

# RA 1771/1772

## Synthesized LF/MF/HF communications receivers

Frequency range 15 kHz to 30 MHz

Unsurpassed signal path performance

High MTBF - Low MTTR

Built-in optional facilities for ISB, FSK and AFC operation

Optional RF tuning and choice of frequency standards

Meet relevant defence/NATO specifications

**Racal Communications Limited**





## Synthesized LF/MF/HF communications receivers type RA 1771/1772

The RA 1770 range of synthesized communications receivers has been designed and manufactured by Racal to meet the exacting requirements of the professional communicator. All receivers within the range are extremely versatile, being a readily adaptable base for fixed and transportable receiving systems. These receivers offer facilities for both general and special purpose applications such as broadcast/re-broadcast networks and surveillance/monitoring systems. In addition to meeting all the relevant defence specifications the RA 1770 series receivers are ideally suited to all civil point-to-point and Post Office roles.

The series consists of a number of derivatives developed from one basic receiver, a compact, solid-state design providing the utmost in reliability with minimum power consumption. To ensure superior performance the receivers use modern proven design concepts with derated components for long term dependable operation.

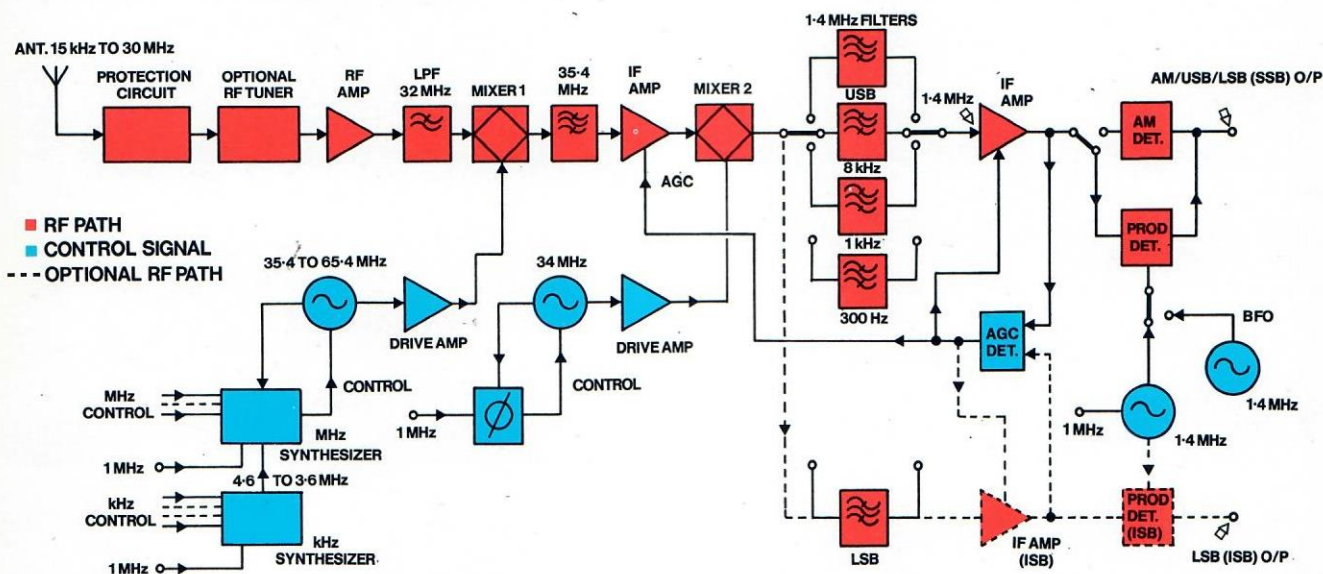
All receivers in the range have the same basic specification; the major difference between them being the method of frequency selection and the optional facilities which may be incorporated to suit particular applications. All versions feature synthesized frequency selection and a front panel layout designed for rapid and easy operation providing highly reliable communications with the operational speed and flexibility demanded by present

day civil and defence users.

This comprehensive range of receivers gives the highest possible level of performance for the requirements of modern HF systems. The RA 1770 series provides exceptional signal handling capabilities within the frequency range 15 kHz to 30 MHz. Covering the LF, MF and HF bands, the receivers have the facilities for reception of SSB (upper or lower sideband), AM and CW modes and optional modules for ISB, FSK and AFC may be included as an integral part of the receivers – thus eliminating the need for external adaptors. The advanced engineering techniques embodied in the receiver design and manufacture ensure the high level of performance in terms of selectivity, sensitivity and stability essential in modern communications systems.

The RA 1772, the nucleus of the 1770 series, is provided with a 'free-tune' facility suitable for all communications, surveillance and monitoring purposes. This receiver employs the unique system of single knob frequency control giving the feel and smoothness of a VFO but retaining the accuracy and stability of the frequency standard at all times. Two rates of tuning may be electronically selected (fast 100 Hz or slow 10 Hz steps) and once the required frequency has been set, the single knob may be electrically disengaged ensuring complete freedom from frequency changes due to vibration or accidental movement.

### Type RA 1771/72 Block diagram



### Principles of Operation

The electrical design of the RA 1770 series incorporates the latest techniques in mixer and signal path development to produce a performance with respect to dynamic range, intermodulation products, reciprocal mixing, cross modulation, blocking and spurious responses far exceeding that found in any receiver of its type in production.

The input signal is routed from the antenna via a protection stage to a linear RF amplifier stage. It is then fed via a 32 MHz low pass filter to the first mixer where it is combined with a variable frequency output from the synthesizer. The frequency of this output, in the range 35.4 to 65.4 MHz, is determined by the frequency of operation and is selected by the setting of the front panel controls. The synthesizer is tuned in 10Hz or 100Hz steps giving slow or fast tuning.

The IF output from the first mixer is routed via a 35.4 MHz band pass filter and an IF amplifier to the second mixer, where it is combined with a 34 MHz output from the synthesizer to provide a final IF of 1.4 MHz. Dependent upon the mode selected, the 1.4 MHz IF signal is then fed to the SSB or IF selectivity filters.

The receiver will accommodate a total of six filters. Two may be asymmetrical SSB/ISB with either 3 kHz or 6 kHz nominal bandwidths, leaving space for fitting IF selectivity filters or AFC carrier filter, according to user requirements. Additional positions for IF selectivity filters become available if SSB/ISB filters are not fitted.

The output from the selected filter passes via the main IF amplifier to an AGC amplifier and detector, which controls the gain of the various IF amplifier stages, and to the detector stage. A product detector is provided for CW/SSB modes and an envelope detector for DSB. For CW operation a variable BFO is fitted, a slow motion drive providing extremely smooth control of the  $\pm 3$  kHz variation of the IF. For SSB or ISB reception a 1.4 MHz output derived from the frequency standard provides a re-inserted carrier.

In the ISB mode two identical IF and AF amplifiers provide separate upper and lower sideband outputs.



Unbroken frequency search facilities are achieved without the need to 'reverse-tune' at the end of each MHz band. An automatic 20 kHz overspill is provided. The frequency read-out is a non-flicker electronic display easily read under all lighting conditions and subjecting the operator to minimum fatigue.

The RA 1771 is available, as an alternative version and has been designed particularly for point-to-point applications where no search facility is required. It is suitable for all forms of reception, and frequency selection is by means of five in-line decadic switches to an accuracy of 10 Hz, the rapid 'lock-in' time of the synthesizer providing the quickest possible setting to a known frequency.

The RA 1771 and RA 1772 receivers may be housed in grey Creeth cases to meet stringent defence requirements for their transportation and operation under field conditions. These receivers retain the same electronic operational and physical characteristics of the RA 1771 and RA 1772 receivers and are designated the RA 1773 and RA 1774 respectively. The Creeth case assemblies include an additional fascia panel (provided as part of Connector Panel Kit MA 1070). This provides front panel access for the AC power supply connection, FSK output, antenna, auxiliary audio outputs and an earth terminal.

In addition to the normal modes of reception provided in the basic receiver, optional units may be fitted within the main receiver frame to permit reception of ISB and FSK signals as well as AFC operation. The standard version of the receiver is fitted with a wideband RF amplifier unit but a separate RF tuner may be built-in as an option when additional pre-selection is considered necessary. As well as the mode selected SSB/ISB filters in the standard receiver, up to four other optional IF filters may be fitted according to user requirements.

The extremely high stability of the 1770 series receivers is achieved by the frequency synthesizer which is referenced to a built-in frequency standard. For most applications, a proportionally controlled ovened oscillator is suitable but less demanding conditions may be met by a simpler temperature compensated crystal oscillator. Alternatively, an external 1 MHz standard may be coupled into the receiver.

The receiver is extremely compact and may be supplied as a standard rack mounting unit or in a free standing bench cabinet. Each receiver is provided with its own self-contained power supply unit permitting operation from either 100/125 or 200/250 volts AC supply.

The mechanical construction used provides an extremely robust receiver capable of operating under adverse environmental conditions of shock, temperature and humidity. The layout permits maximum accessibility for servicing, all components being accessible without the use of extension leads or adaptors.

All receivers meet NATO specifications, and the following NATO stock numbers have been allocated:-

RA 1771 5820-99-626-3415

5820-99-624-5397

RA 1772 5820-99-630-9620

5820-99-635-9352

5820-99-635-9353.

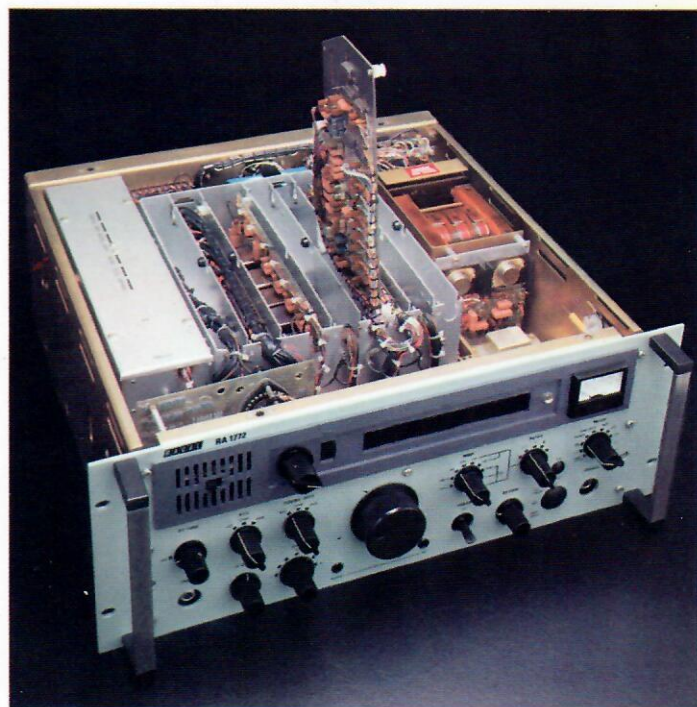
All these receivers are essentially operator's units being simple and easy to use. The layout of all front panel controls has been chosen following many thousands of hours of field operation in both fixed and mobile station roles. All units are subjected to a rigorous programme of environmental testing to prove the performance of the equipment under extreme climatic and physical conditions and also ensure high MTBF and MTTR rates.

The flexibility of the receiver is further enhanced by the provision of comprehensive input and output connectors on the rear of the chassis permitting diversity operation and the use of the receiver as the basis of a more sophisticated receiver system.

Comprehensive front panel metering facilities provide indications of RF level, AF level, FSK tune and supply tests levels. A switched monitor loudspeaker and two front panel headphone jacks are provided.



RA 1771 Point-to-point communications receiver



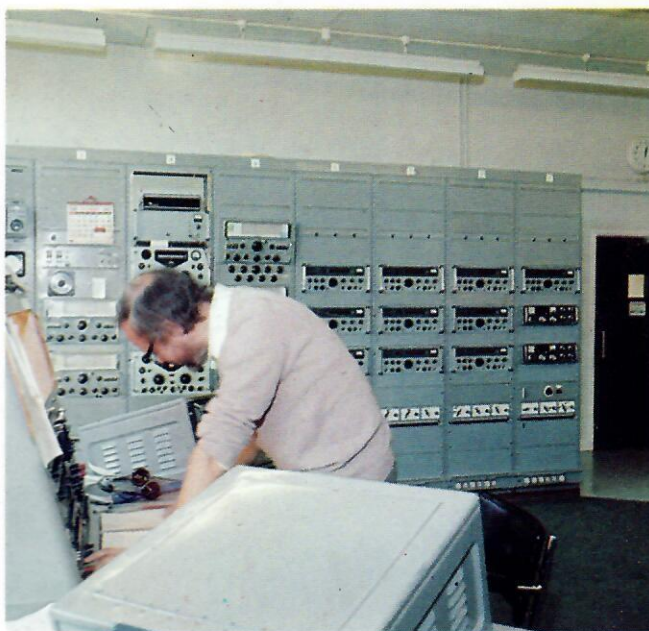
Ease of accessibility is a feature of the RA 1770 series receivers. The circuit boards may be raised into the position shown for test and maintenance purposes.



Rear view of RA 1772 receiver showing connectors and other user facilities.



## Applications of RA 1770 series receivers



### Defence – (Top left)

RA 1772 receivers are in service with the Royal Air Force in both static and transportable roles.

### Broadcasting – (Top right)

Broadcasting authorities, including the BBC, use the Racal receivers for monitoring and re-broadcast purposes.

### Post Office – (Centre left)

The Post Office use RA 1772 receivers in many different roles including ship/shore communications.

### Marine – (Centre right)

Receivers in the RA 1770 series are widely used in marine installations.

### Transportable – (Lower left)

The rugged design makes the RA 1770 series ideal for installation in transportable stations.



## Technical Specification

### Frequency range

15 kHz – 30 MHz.

### Modes of reception

A1, A2, A2H, A2J, A3, A3A, A3J, A3H with the following options:

- (i) Choice of USB or LSB.
- (ii) Provision for reception of A3B or F1.
- (iii) Provision of AFC.

### Tuning

(a) RA 1771 and RA 1773.

Switched selection of 1 MHz steps and in-line decadic switching of synthesizer in 10 Hz steps over each 1 MHz band.

(b) RA 1772 and RA 1774.

Switched selection of 1 MHz steps and a continuously tunable synthesizer in 10 Hz or 100 Hz steps over each 1 MHz band.

Electronic readout of each 1 MHz band to increments of 10 Hz.

### Overspill

RA 1772 and RA 1774.

20 kHz at either end of each 1 MHz band.

Over-run indication is provided.

### Tuning accuracy

± 5Hz relative to the frequency of the wanted signal.

### Frequency stability

(1) The following optional alternative frequency standards may be fitted:

(a) Temperature Controlled Crystal Oscillator (TCXO).

(i) Temperature: Better than ± 1.5 in 10<sup>6</sup> from -10°C to 55°C.

(ii) Long Term: ± 2 in 10<sup>7</sup> over a 30 day period.

(b) Frequency Standard Type 9400.

(i) Temperature: ± 1 in 10<sup>6</sup>/°C.

(ii) Long Term: ± 1.5 in 10<sup>7</sup> over a 30 day period or ± 5 in 10<sup>9</sup> per day.

(c) Frequency Standard Type 9420.

(i) Temperature: ± 6 in 10<sup>6</sup>/°C.

(ii) Long Term: ± 1.5 in 10<sup>9</sup> over a 30 day period or ± 5 in 10<sup>10</sup> per day.

(2) Provision is made for the use of an external frequency standard.

### Antenna input

(a) Wideband. 50 ohms to 75 ohms nominal. BNC coaxial connector.

(b) RF tuning is available as an optional fitting within the receiver. This is provided by five automatically selected bandpass filters covering the frequency range 1 MHz to 30 MHz. Manual RF peak tuning is provided over each pre-selected band of frequencies. Each tuned range provides a nominal attenuation of 20 dB at 12½% off-tune. A low pass filter is used below 1 MHz.

(c) Receiver muting is provided to protect the receiver from local emissions on the tuned frequency. The operation of the muting circuits permits 'break-in' or 'listen through' operation when keying at a rate of up to 20 bauds.

(d) The receiver will withstand without damage RF input signals of 30 V (EMF) continuously. A fuse and spark gap is provided for protection against higher voltages.

(e) Re-radiation with the antenna input terminated in 50 ohms is less than 10 microvolts.

### Sensitivity

(a) CW and SSB (A1, A2H, A3A, A3H, A3J).

In a 3 kHz bandwidth the signal-to-noise ratio is better than:

500 kHz – 30 MHz, 15 dB with 1 μV (EMF) input.

50 kHz – 500 kHz, 15 dB with 3 μV (EMF) input.

15 kHz – 50 kHz, 15 dB with 10 μV (EMF) input.

(b) DSB (A2, A3)

In a 3 kHz bandwidth the signal-to-noise ratio is better than:

500 kHz – 30 MHz, 15 dB with 1.5 μV (EMF) input 70% modulated.

50 kHz – 500 kHz, 15 dB with 5 μV (EMF) input 70% modulated.

15 kHz – 50 kHz, 15 dB with 15 μV (EMF) input 70% modulated.

### IF selectivity

(a) SSB (A3A, A3J).

Passband at -6 dB: 250 Hz to 3000 Hz.

Passband at -60 dB: -400 Hz and +4100 Hz.

or alternatively

Passband at -6 dB: 250 Hz to 6000 Hz.

Passband at -60 dB: -300 Hz and +8000 Hz.

(b) ISB (A3B)

Passband at -6 dB: 250 Hz to 3000 Hz.

Passband at -60 dB: -400 Hz and +4100 Hz.

or alternatively

Passband at -6 dB: 250 Hz to 6000 Hz.

Passband at -60 dB: -300 Hz and +8000 Hz.

(c) CW/MCW/AM/FSK (A1, A2, A3, A2H, A3H, F1).

Standard Receivers. In addition to the mode-selected SSB or ISB filters, up to four optional IF filters may be fitted although certain combinations of facilities will permit only three filters to be fitted. IF filters of the following nominal passbands are available: 0.3 kHz, 1 kHz, 3 kHz, 6 kHz, 8 kHz, 13 kHz.

### Cross modulation

With a wanted signal greater than 300 μV EMF, in a 3 kHz bandwidth, an unwanted signal, 30% modulated, removed not less than 20 kHz, will be greater than 300 mV EMF, to produce an output 20 dB below the output produced by the wanted signal.

### Reciprocal mixing

With a wanted signal of less than 100 μV EMF, in a 3 kHz bandwidth, an unwanted signal more than 20 kHz removed will be greater than 70 dB above the wanted signal level to give a noise level 20 dB below the output produced by the wanted signal.

### Blocking

With a wanted signal of 1 mV EMF, an unwanted signal more than 20 kHz removed must be greater than 500 mV to reduce the output by 3 dB.

### Intermodulation products

(a) Out of Band.

With two 30 mV EMF signals separated and removed from the wanted signal by not less than 20 kHz the third order intermodulation products are not less than -85 dB below either of the interfering signals and typically better than -90 dB.

(b) In Band.

Two in band signals of 30 mV EMF will produce third-order intermodulation products of not greater than -40 dB.

### Spurious responses

(a) External

External signals, 20 kHz removed from the wanted signal, must be at least 80 dB above the level of the wanted signal to produce an equivalent output.

(b) Internal

The performance as stated in this specification is applicable to the wideband condition only. If the optional RF Tune assembly is fitted, an additional 20 dB protection is given half an octave or more from the wanted signal over the 1 – 30 MHz range and there is an insertion loss of up to 2 dB which may modify the sensitivity.

The specified sensitivity figures in the CW/SSB modes are not reduced by more than 3 dB as a result of any internally generated spurious signals.

### AGC

(a) Range.

An increase in input of 100 dB above 2 microvolts EMF will produce an output change of less than 6 dB.

(b) Switched selection of AGC 'off', 'short' and 'long' time constants.

### AFC (A3A, A3B) (optional)

(a) AFC is available as an optional internal facility and is provided with a front panel switch for switching AFC in or out of operation.

(b) Capture range: ± 50 Hz.

Follow range: ± 500 Hz or beyond.

Residual Error: 2 Hz max.

Memory: In the event of carrier failure, or worsening of the carrier to noise/modulation level of 10 dB no retuning is necessary for fades of up to 1 minute.

### BFO range

± 3 kHz variable by a slow motion control.

### IF output (AGC on)

1.4 MHz, nominally 100 mV (EMF) into 50 ohms.

### Audio characteristics

(a) Output Levels:

(i) Line outputs, 1 mW nominal into 600 ohms balanced, adjustable by preset level control on front panel to +6 dBm.

(ii) Phone outputs unbalanced, 10 mW nominal into 600 ohms.

(iii) 50 mW into an internal loudspeaker which is capable of being switched in or out of operation.

(iv) Connection for external speaker 1 watt into 8 ohms.

(b) AF Response:

(i) Line outputs. Within 1 dB from 100 Hz to 6000 Hz relative to the level of a standard 1000 Hz tone.

(ii) The overall AF response will be dependent upon the IF bandwidth selected.

(c) Distortion:

(i) Line outputs. Not greater than 2% at specified output of 1 mW nominal.

(ii) Loudspeaker outputs; Not greater than 5% at 50 mW output to internal loudspeaker, and 1W output to external speaker.

(iii) Phone outputs. Not greater than 5% at specified output of 10 mW nominal.

### Cross talk (A3B)

With a wanted signal at a level of 1 mV and the AF output adjusted to 1 mW, the cross talk from an equal signal in the opposite sideband, at greater than 400 Hz from the carrier, is not greater than -50 dB relative to 1 mW.

### Frequency shift demodulation (optional)

(a) Frequency shift range, 85 Hz to 850 Hz.

(b) Maximum keying speed 200 bauds.

(c) Telegraph distortion not greater than 5% up to 100 bauds.

(d) Telegraph output. Polar (double current) DC output approximately 100 mA with choice of 6 – 0 – 6V or 80 – 0 – 80V. Normally positive on 'Mark'. Provision is made by a rear panel switch for neutral (single current) operation.

(e) Mark/space reversal is available to the operator and a 'tune' switch position is provided to permit tuning of the receiver without operating the teleprinter.



## Technical Specification (continued)

A meter is provided on the front panel to indicate RF level, AF level to line, FSK tune, and suitable performance or supply test levels.

100 V-125 V or 200 V-250 V,  $\pm 10\%$ ,  
45-65 Hz.

Approximately 60VA (Basic receiver).  
Approximately 90VA (Fully equipped).

The equipment is designed to meet certain of the requirements of the British Defence Specification DEF 133, L2, for ambient temperature range of:  
Operating Temperature  $-10^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$ .  
Storage Temperature  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .  
Relative Humidity 95% at  $40^{\circ}\text{C}$ .

(a) RA 1771 and RA 1772.  
Rack Mounted In Bench Cabinet  
Height: 178 mm (7 in). 220 mm (8.65 in).  
Width: 483 mm (19 in). 495 mm (19.5 in).  
Depth: 410 mm (16.15 in). 445 mm (17.5 in).

(b) RA 1773 and RA 1774.  
In Creeth Case  
Height: 351 mm (13.8 in).  
Width: 518 mm (20.4 in).  
Depth: 572 mm (22.5 in).

(a) RA 1771 and RA 1772.  
Rack Mounted In Bench Cabinet  
22 kg (48.5 lb). 28 kg (61.5 lb).

(b) RA 1773 and RA 1774.  
In Creeth Case  
42.3 kg 93 lb

**AA 660/A**  
Headset, 600 ohms, with ventilated ear cushions, lead and plug.  
Headsets are also available with standard ear cushions and anti-perspiration covers.

Bench Mounting Cabinet.

**Ruggedized Bench Mounting Cabinet for marine applications.**

Ruggedized Bench Mounting Cabinet fitted with shock mounts for mobile/transportable applications.

**MM 530**  
Bandpass filter 2–30 MHz, for use in receiver antenna systems.

Telephone Diversity Switching Units, for SSB and ISB operation respectively. For use in speech diversity systems.

for SSB and ISB operation respectively. Provides 100 kHz output(s) for use with ancillary equipment.

**All accessories and optional facilities and modules to be specified at time of order.**



### RA 1773 Point-to-point communications receiver in Creeth case for field operation



RA 1774 Ruggedized free-tune communications receiver

*Racal reserve the right to vary in detail from the description and specification in this publication.*

**RACAL**

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